ADDENDUM K

Seward Park Vegetation Management Plan

Literature Sources for Additional Information on Select Topics

Poison Oak

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In this Guideline: PDF to Print

Poison oak or western poison oak, *Toxicodendron diversilobum,* is native to western North America, with a distribution extending from British Columbia south to the Baja California peninsula. In Washington and Oregon, poison oak is found mainly in the western regions of the states. In California it is widespread and grows in a wide range of habitats from sea level to the 5000-foot elevation, including open woodland, grassy hillsides, coniferous forests, and open chaparral.

IDENTIFICATION

Poison oak is a deciduous (loses leaves in winter), woody plant that can have a shrub or vine form. In open areas under full sunlight, poison oak forms a dense leafy shrub usually 1 to 6 feet in height. In shaded areas, such as in coastal redwoods and oak woodlands, it becomes a much taller climbing vine, supporting itself on other vegetation or upright objects by means of aerial roots.

Leaves normally consist of three leaflets with the stalk of the central leaflet being longer than those of the other two; however, occasionally leaves are composed of five, seven, or nine leaflets. Leaves of true oaks, which are superficially similar, grow singly, not in groups. Poison oak leaves are alternate on the stem. Each leaflet is 1 to 4 inches long and smooth with toothed or somewhat lobed edges. The diversity in leaf size and shape accounts for the Latin term *diversilobum* in the species name. The surface of the leaves can be glossy or dull, sometimes even somewhat hairy, especially on the lower surface. In spring, poison oak produces small, white-green flowers at the point where leaves attach to the stem. Whitish-green, round fruit form in late summer. In early spring the young leaves are green or sometimes light red. In late spring and summer the foliage is glossy green, and later turns attractive shades of orange and red.

IMPACT

Although a native, poison oak can be found in great abundance where established vegetation is disturbed, particularly along roadsides, in uncultivated fields, and on abandoned land. It is also a problem in wood lots, Christmas tree plantations, rangeland, and recreation areas. While it can reduce optimal grazing area in rangeland or pastures, the primary concern associated with poison oak is the allergic reaction it causes in many people.

All members of the genus *Toxicodendron,* including poison oak, poison ivy, and poison sumac, cause allergic contact dermatitis. About two million cases of skin poisoning are reported in the United States each year, primarily caused by these three species. In California, the number of working hours lost as a result of dermatitis caused by poison oak makes it the most hazardous plant in the state.

Contact with poison oak leaves or stems at any time of the year can cause an allergic response. When the allergen contacts the skin surface in sensitive individuals, it is rapidly absorbed into the surrounding cells. Within 1 to 6 days, skin irritation and itching will be followed by water blisters, which can exude serum. Contrary to popular belief, the exuded serum does not contain the allergen and does not transmit the rash to other regions of the body or to other individuals. The dermatitis rarely lasts more than 10 days.

Although 50% of the population is clinically sensitive to poison oak and poison ivy, about 75 to 85% can potentially develop an allergy if exposed to a sufficiently high concentration of the toxin. Once a reaction to the toxin has occurred, the body responds with a cell-mediated immunity, which is a delayed hypersensitivity. Those individuals who have developed delayed hypersensitivity are sensitive to the toxin and repeated exposures further increase sensitivity. Conversely, long periods with no exposure will reduce an individual's susceptibility to the allergen. There is no known difference in sensitivity to poison oak among races or between sexes. Animals do not usually suffer skin irritation from contact with poison oak because they are protected by fur; dogs, however, can contact poison oak on their nose or underbelly. On the other hand, livestock may graze on the tender foliage with no adverse effects.

In addition to direct contact with the plant, transmission of the allergen can occur from a number of other sources including smoke particles, contact with objects such as clothing, gloves, and tools, or contact with animals, particularly pets. When poison oak is burned, the oils can be transported on the smoke particles. Breathing this smoke can cause severe respiratory irritation.

After coming in contact with the allergen, the best way to prevent skin irritation is to pour a mild solvent, such as isopropyl alcohol (rubbing alcohol), over the exposed area and then follow this with plenty of cold water (warm water enhances penetration of the oil) within a few minutes of exposure. If isopropyl alcohol is not available, just wash with *lots* of cold water. But you need to wash within 5 minutes of exposure to prevent a rash. Even if it is too late to prevent the rash, washing the skin to remove excess plant oil will keep the rash from spreading. The poison oak toxin is an oil, so it does not dissolve in water. Sufficient quantities of water, however, will dilute the oil to the point where it is no longer harmful.

Using only a small amount of water or disposable hand wipes is more likely to spread the toxin than remove it. Soaps can be used to wash, but only if used with copious amounts of water; otherwise, they too will spread the toxin.

An important point to remember when washing with isopropyl alcohol or soaps following exposure to poison oak is that they will remove the skin's protective oils. These oils help the skin repel the plant toxin and will not regenerate for 3 to 6 hours following washing with these solvents. Therefore, wash with them only if you are done working outside for the day. If there is a possibility of reexposure to poison oak within 6 hours, just wash with lots of water. Be sure to thoroughly wash the hands as they serve as the major route for transfer of the allergen to other parts of the body, especially the face.

If a rash develops after exposure to poison oak, the use of a product called Tecnu, which is sold at most drug stores, will relieve the itch and reduce the rash. When applied once a day, it stops the itching for most of the day and clears up the rash in about 7 days.

BIOLOGY

Initial establishment of poison oak is generally by seed that is transported by birds. The single-seeded fruit are eaten by a variety of birds. The passage of the hard-seeded fruit through the bird's digestive tract facilitates germination by reducing the period of dormancy. Birds serve to disperse the seeds to new locations. Once established, the plant spreads by slow vegetative growth of underground horizontal rootstalks (actually stem tissue). A single root system can cover a very large area.

Poison oak can survive under a wide range of temperatures, elevations, soil types, moisture conditions, and light intensities. However, it is most commonly found on hillsides with shallow soils. The flowers of poison oak are usually pollinated by insects.

MANAGEMENT

The primary ways of managing poison oak are mechanical removal by hand-pulling (not recommended for individuals who are sensitive to poison oak) and treatment with herbicides. Maintaining a healthy cover of desirable vegetation will reduce the potential for invasion by poison oak. This is easiest where irrigation is available and the soil is regularly cultivated.

Poison oak is a native species with its natural control agents already present. Consequently, biocontrol is not an option for the control of poison oak. Burning is not recommended for the control of poison oak. It not only creates a serious health hazard, but does not effectively reduce infestations. Grazing by sheep and goats can be effective in small areas. Deer or horses will also graze poison oak when the foliage is young, before the plant flowers.

Mechanical

Hand-pulling or mechanical grubbing (using a shovel, pick, etc.) can be used to physically remove plants located in a yard or near houses. Remove plants in early spring or late fall when the soil is moist and the rootstalks are easily dislodged. Grubbing when the soil is dry and hard will usually break off the stems, leaving the rootstalks to vigorously resprout. Detached and dried brush can still cause dermatitis, so bury or stack the plant material in an out-of-the-way location, or take it to a disposal site. Never burn poison oak.

Ideally, persons engaged in hand-pulling poison oak should have a high degree of immunity to the allergen. Whether the individual is sensitive or believed to be immune, he or she should wear appropriate protective clothing, including washable cotton gloves over plastic gloves, when handling the plants. Wash all clothing thoroughly, including shoes, after exposure.

Other forms of mechanical control have not proven to be successful. Brushrakes and bulldozers often leave pieces of rootstalks that can readily resprout. In some cases, brush removal late in summer, when plants are experiencing moisture stress, can slow their ability to recover. Mowing has little effect in poison oak control, unless it is performed repeatedly (at least four times during the growing season). Within 2 months of germination, young plants have usually produced underground rootstalks large enough to recover from mowing damage. A single plowing is of no value and often serves to propagate the shrub. However, good seedbed preparation and planting cultivated crops for a year or more will control poison oak infestations.

Chemical Control

Herbicides used to control poison oak in California include glyphosate (Roundup, etc.) and the auxinic herbicides triclopyr (Garlon, Ortho Brush-B-Gon, etc.), 2,4-D (Spurge & Oxalis Killer, etc.), and dicamba (Banvel, Spurge & Oxalis Killer, etc.). These herbicides can be applied as stump or basal applications, or as a foliar spray.

Glyphosate is one of the most effective herbicides for the control of poison oak. However, effective control depends upon proper timing of the application. Apply glyphosate late in the growth cycle, after fruit have formed but before leaves lose their green color. In hand-held equipment, glyphosate can be applied as a 2% solution in water. (Products or spray mixtures containing less than 2% glyphosate may not effectively control poison oak.) It is important to note that glyphosate is a nonselective compound and will damage or kill other vegetation it contacts.

Auxinic herbicides, such as triclopyr, 2,4-D, dicamba, and combinations of these herbicides, are also used to control poison oak. The application timing with auxinic herbicides is somewhat different than for glyphosate: applications can be made earlier than with glyphosate, when plants are growing rapidly from spring to midsummer.

Triclopyr is the most effective auxinic herbicide for control of poison oak. It has a wider treatment window than glyphosate and it often gives more consistent control. Two formulations of triclopyr are available. Triclopyr amine is the least effective of the formulations and requires relatively high rates. Triclopyr ester or triclopyr ester plus 2,4-D ester gives better herbicide absorption into the foliage and is more effective.

When 2,4-D is combined with dicamba, it provides much better control than if it is used alone in a 1% solution. Premixed combinations of these herbicides are available. Dicamba applied at 0.5% gives better long-term control of poison oak than 2,4-D.

A new herbicide in California, imazapyr, is also very effective for the control of poison oak, but is only

available for application by licensed pesticide applicators. In forestry, there are two formulations. The water soluble formulation (Arsenal) is effective as a foliar treatment at 1% plus a 0.25% surfactant. A similar treatment with an emulsifiable concentrate formulation (Chopper, Stalker) will control poison oak at a 2% solution in water or a 1% solution plus 5% of a methylated or ethylated seed oil. The best timing is in either spring after full leaf expansion or in late summer (mid-August through September).

Stump Application. Stump treatments are most effective during periods of active growth. Cut stems of poison oak 1 to 2 inches above the soil surface and immediately after cutting, treat the stump. A delay in treatment will result in poor control. Apply an herbicide such as glyphosate, triclopyr, or combinations of triclopyr with 2,4-D (or 2,4-D and 2,4-DP) with a 1- to 2-inch-wide paint brush or with a plastic squeeze bottle that has a spout cap. Treatment solutions should contain either undiluted glyphosate (use a product that contains at least 20% glyphosate), triclopyr amine, or a 20 to 30% triclopyr ester solution mixed with 70 to 80% oil (methylated or ethylated seed oils).

Be sure to completely cover all surfaces of the stumps with the herbicide until it runs down the base of the stubs. Spray any regrowth from cut stumps with a foliar spray when the leaves fully expand.

Basal Application. Basal bark applications can be made almost any time of the year, even after leaves have discolored or dropped. Apply triclopyr to basal regions of poison oak by backpack sprayers using a solid cone, flat fan, or a straight-stream spray nozzle. Thoroughly cover a 6- to 12-inch basal section of the stem, but not to the point of runoff.

Foliar Sprays. The effectiveness of herbicides applied to poison oak foliage depends on three factors: (1) proper growth stage at time of application; (2) spray-to-wet coverage; and (3) proper concentration. To achieve spray-to-wet coverage, all leaves and stems should be glistening following herbicide application. However, coverage should not be to the point of runoff.

Foliar application of herbicides to poison oak is most effective after leaves are fully developed and when the plant is actively growing. This period is normally from April into June or July, when soil moisture is still adequate. The flowering stage is the optimum time to spray. Do not apply herbicides before plants begin growth in spring or after the leaves have begun to turn yellow or red in late summer or fall.

One application of a herbicide usually does not completely control poison oak. Re-treat when new, sprouting leaves are fully expanded, generally when the plants are about 2 feet tall. Watch treated areas closely for at least a year and re-treat as necessary.

WARNING ON THE USE OF CHEMICALS

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Quercus garryana Dougl. ex Hook.

Oregon White Oak

Fagaceae -- Beech family

William I. Stein

Oregon white oak *(Quercus garryana),* a broadleaved deciduous hardwood common inland along the Pacific Coast, has the longest north-south distribution among western oaks-from Vancouver Island, British Columbia, to southern California. It is the only native oak in British Columbia and Washington and the principal one in Oregon. Though commonly known as Garry oak in British Columbia, elsewhere it is usually called white oak, post oak, Oregon oak, Brewer oak, or shin oak. Its scientific name was chosen by David Douglas to honor Nicholas Garry, secretary and later deputy governor of the Hudson Bay Company.

Habitat

Native Range

The range of Oregon white oak spans more than 15° of latitude from just below the 50th parallel on Vancouver Island in Canada south nearly to latitude 34° N. in Los Angeles County, CA. South of Courtenay, BC, Oregon white oak is common in the eastern and southernmost parts of Vancouver Island and on adjacent smaller islands from near sea level up to 200 m (660 ft) or more (47). It is not found on the British Columbia mainland except for two disjunct stands in the Fraser River Valley (28). In Washington, it is abundant on islands in Puget Sound and distributed east and west of the Sound and then south and east to the Columbia River at elevations up to 1160 m (3,800 ft) (68). Oregon white oak is widespread at lower elevations in most of the Willamette, Umpqua, and Rogue River Valleys of western Oregon (67,68). It is also common in the Klamath Mountains and on inland slopes of the northern Coast Ranges in California to San Francisco Bay but infrequent from there southward to Santa Clara County (29).

In small tree and shrub sizes, Oregon white oak extends inland to just east of the Cascade Range, mainly in the Columbia River and Pit River drainages (29,50,67,68,71). It has a scattered distribution the entire length of the western Sierra Nevada south to the Tehachapi Mountains in Kern and northern Los Angeles Counties where it forms extensive brush fields at elevations up to 2290 m (7,500 ft) (29,76).

-The native range of Oregon white oak.

Climate

Oregon white oak grows in diverse climates, ranging from the cool, humid conditions near the coast to the hot, dry environments in inland valleys and foothill woodlands. Records from 48 climatic observation stations within or bordering its range indicate that Oregon white oak has endured temperature extremes of -34° to 47° C (-30° to 116° F) (45,47,53,77). Average annual temperatures range from 8° to 18° C (46° to 64° F); average temperatures in January, from -11° to 10° C (13° to 50° F); and in July, from 16° to 29° C (60° to 84° F).

Average annual precipitation ranges from 170 mm (6.7 in) at Ellensburg, WA, east of the Cascades to 2630 mm (103.5 in) at Cougar, WA, west of the Cascades. Precipitation at the southern end of the range of Oregon white oak (Tehachapi) averages 270 mm (10.6 in), similar to that at northerly locations east of the Cascades-Ellensburg, Yakima, and Goldendale in Washington and The Dalles and Dufur in Oregon. Average annual snowfall ranges from little, if any, at several locations to 417 cm (164 in) at Mineral in Tehama County, CA. Average precipitation in the growing season (April through September) ranges from 30 mm (1.2 in) at Tehachapi, CA, and Ellensburg, WA, to 630 mm (24.8 in) at Cougar, WA. Length of average frost-free season (above 0° C; 32° F) ranges from 63 days at Burney in Shasta County, CA, to 282 days at Victoria, BC.

Soils and Topography

Oregon white oak can grow on a wide variety of sites, but on good sites it is often crowded out by species that grow faster and taller. Hence, Oregon white oak is most common on sites that are too exposed or droughty for other tree species during at least part of the year, including inland valleys and foothills, south slopes, unglaciated and glaciated rocky ridges, and a narrow transition zone east of the Cascades between conifer forest and treeless, dissected plateau. Although usually considered a xeric species, Oregon white oak also commonly occurs in very moist locations-on flood plains, on heavy clay soils, and on river terraces. These locations appear to have two common characteristics-standing water or a shallow water table during a lengthy wet season and gravelly or heavy clay surface soils that probably are droughty during the extended dry season. The distribution of Oregon white oak gives evidence that it can withstand both lengthy flooding and drought.

Oregon white oak grows on soils of at least four orders: Alfisols, Inceptisols, Mollisols, and Ultisols. Specific soil series include Hugo and McMahon in coastal northern California and Goulding near Santa Rosa (75,78). In Oregon's Willamette Valley, Oregon white oak is found on soils derived from alluvial deposits (poorly drained gray brown Amity and Dayton series), sedimentary rocks (deep, welldrained brown Steiwer, Carlton, Peavine, Bellpine, Melbourne, and Willakenzie series), and basic igneous rocks (brown or reddish, moderately deep, well-drained Nekia, Dixonville, and Olympic series) (22,38,67,73). A subsurface clay layer that restricts water penetration is characteristic of soils in most of these series. White oak stands near Dufur in eastern Oregon grow in soils derived from basalt and andesite (32); in southern Oregon, they grow in soils derived from andesite, granite, and serpentine (79). On the southeastern tip of Vancouver Island, BC, seven soils supporting a vegetational sequence of grass, Oregon white oak, and Douglas-fir were gravelly loams or gravelly sandy loams that developed on young, nonhomogeneous parent materials (11).

Soils under Oregon white oak stands are generally acidic, ranging in pH from 4.8 to 5.9 (11,75,78). Bulk densities ranging from 0.61 to 1.45 have been measured (73,78). Many white oak stands grow on gentle topography; only one-fourth of those examined in the Willamette Valley were on slopes greater than 30 percent (73).

Associated Forest Cover

Oregon white oak is found in pure, closed-canopy stands; in mixture with conifers or broad-leaved trees; and as scattered single trees or groves on farmlands, woodlands, and prairies. It grows to large sizes but is also found extensively as scrub forest. The best stands are in western Oregon and Washington-in the Cowlitz, Lewis, and Willamette River drainages-but stands or trees with substantial volume are found from British Columbia to central California. Dense dwarf or shrub stands of Oregon white oak, earlier identified as *Quercus garryana* var. *breweri*, and other stands previously identified as Q. *garryana* var. *semota*, form dense thickets over large areas in California (29,35,57,76,81). Similar dwarf or shrub forms grow to a more limited extent on severe sites in the rest of its range (57,79).

Oregon white oak is recognized as a distinct forest cover type (Society of American Foresters Type 233) and is listed as an associated species in at least eight other forest cover types (20): Pacific Douglas-Fir (Type 229), Port Orford-Cedar (Type 231), Redwood (Type 232), Douglas-Fir-Tanoak-Pacific Madrone (Type 234), Pacific Ponderosa Pine (Type 245), California Black Oak (Type 246), Knobcone Pine (Type 248), and Blue Oak-Digger Pine (Type 250). Its prominence and occurrence in these types, as well as in several others for which it is not specifically listed, vary widely.

Plant communities have been identified in parts of the Oregon white oak type. A Garry oak community of two types (oak parkland and scrub oak-rock outcrop), a Garry oak-arbutus, and an arbutus-Garry oak community have been defined in the Victoria, BC, metropolitan area (42). Four communities, ranked in order from wettest to driest, have been identified in white oak forests of the Willamette Valley: Oregon white oak/California hazel/western swordfern, Oregon white oak/sweet cherry/common snowberry, Oregon white oak/Saskatoon serviceberry/common snowberry, and Oregon white oak/Pacific poison-oak (73). These communities are floristically similar, being differentiated primarily by the relative coverage and frequency of a few shrub species. Five Oregon white oak communities identified in the North Umpqua Valley of Oregon were similar to the xeric Oregon white oak/Pacific poison-oak association of the Willamette Valley; a sixth was a riparian association dominated by Oregon white oak and Oregon ash *(Fraxinus latifolia)* (62). In California, four communities dominated by Oregon white oak were found in the Bald Hills woodlands of Redwood National Park (70) and three communities dominated by Oregon white oak or related hybrids were identified in a limited area on Bennett Mountain (75). The shin oak brush association, largely composed of Oregon white oak, is a distinctive plant community in Kern and Los Angeles Counties (76).

The composition of Oregon white oak communities varies greatly because of differences in soil, topography, and climate, and in fire and grazing histories. Because of proximity to farmlands, many communities include introduced forbs and grasses. Pacific poison-oak *(Rhus diuersiloba)* and common snowberry *(Symphoricarpos albus)* are probably the most widespread and characteristic shrub associates.

Species often found with Oregon white oak are listed in table 1. The listing is not exhaustive; it just indicates the great variety of common associates. Species associated

with Oregon white oak in chaparral communities and on serpentine soils are listed in other sources (15,16,79).

Table 1- Trees, shrubs, and herbs associated with Oregon white oak in different parts of its range[1]

Trees	Shrubs	Herbs
Abies grandis	*Amorpha californica*	*Agropyron spicatum*
Acer circinatum	*Arctostaphylos columbiana*	*Agrostis* spp.
Acer glabrum	*Arctostaphylos manzanita*	*Allium* spp.
Acer macrophyllum	*Arctostaphylos media*	*Athysanus pusillus*
Aesculus californica	*Arctostaphylos uva-ursi*	*Avena barbata*
Alnus rubra	*Berberis aquifolium*	*Balsamorhiza deltoides*
Amelanchier alnifolia	*Berberis nervosa*	*Brodiaea* spp.
Arbutus menziesii	*Ceanothus cuneatus*	*Bromus* spp.
Betula occidentalis	*Ceanothus integerrimus*	*Camassia* spp.
Castanopsis chrysophylla	*Ceanothus velutinus*	*Carduus pycnocephalus*
Cercocarpus betuloides	*Cornus stolonifera*	*Carex* spp.
Cornus nuttallii	*Crataegus oxyacantha*	*Chlorogalum pomeridianum*
Corylus cornuta	*Cytisus scoparius*	*Collinsia* spp.
Crataegus douglasii	*Gaultheria shallon*	*Crocidium multicaule*
Fraxinus latifolia	*Hedera helix*	*Cynosurus echinatus*
Heteromeles arbutifolia	*Holodiscus discolor*	*Dactylis glomerata*
Juniperus scopulorum	*Osmaronia cerasiformis*	*Danthonia californica*
Libocedrus decurrens	*Philadelphus lewisii*	*Delphinium menziesii*
Lithocarpus densiflorus	*Physocarpus capitatus*	*Dentaria californica*
Pinus contorta	*Purshia tridentata*	*Dodecatheon hendersonii*

Pinus monticola
Pinus ponderosa
Pinus sabiniana
Populus tremuloides
Populus trichocarpa
Prunus avium
Prunus emarginata
Prunus virginiana
Pseudotsuga menziesii
Pyrus communis
Pyrus fusca
Pyrus malus
Quercus agrifolia
Quercus chrysolepis
Quercus douglasii
Quercus kelloggii
Rhamnus purshiana
Salix spp.
Sambucus cerulea
Taxus brevifolia
Thuja plicata
Tsuga heterophylla
Umbellularia californica
Rhus diversiloba
Ribes sanguineum
Rosa eglanteria
Rosa gymnocarpa
Rosa nutkana
Rubus laciniatus
Rubus parviflorus
Rubus procerus
Rubus ursinus
Spiraea betulifolia
Spiraea douglasii
Symphoricarpos albus
Symphoricarpos mollis
Symphoricarpos rivularis
Vaccinium ovatum
Vaccinium parvifolium
Viburnum ellipticum
Dryopteris arguta
Elymus glaucus
Eriogonum nudum
Eriophyllum lanatum
Erythronium oregonum
Festuca spp.
Fritillaria lanceolata
Galium spp.
Holcus lanatus
Hypericum perforatum
Lathyrus spp.
Lomatium utriculatum
Lonicera ciliosa
Lotus micranthus
Lupinus spp.
Melica geyeri
Mimulus spp.
Montia spp.
Nemophila heterophylla
Osmorhiza spp.
Phacelia linearis
Platyspermum scapigera
Plectritis spp.
Poa pratensis
Polystichum munitum
Pteridium aquilinum
Ranunculus spp.
Sanicula crassicaulis
Sedum spathulifolium
Sherardia arvensis

Silene californica
Sisyrinchium douglasii
Stipa spp.
Thysanocarpus curvipes
Trifolium tridentatum
Vicia americana
Viola ocellata
Zigadenus venenosus

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[1] Sources:
4,10,11,13,20,22,24,28,31,32,35,42,47,54,62,63,67,69,70,71,72,73,75,78

Life History

Reproduction and Early Growth

Flowering and Fruiting- Oregon white oak flowers somewhat later in the spring than many of its associates. Flowering has been noted in March, April, May, and June (72,74), but the seasonal span is probably greater over the wide range of latitudes and elevations where this species occurs. Flowers appear concurrently with new leaves and extension of twig growth.

The species is monoecious, bearing slim, staminate flowers (catkins) that emerge from buds on existing twigs and also appear on the basal end of developing twigs (64). Some catkins associated with new twig growth just originate from the same bud; others are located as much as 5 mm (0.2 in) from the base on new growth. Catkins are pale yellow tinged with green. Fully extended catkins vary greatly in length-in one collection, from 3 to 10 cm (1.2 to 3.9 in). Catkins of the same twig and cluster are in various stages of development-some are fading before others reach full size. The faded dry catkin is light brown and fragile.

The closed pistillate flowers are small, deep red, and covered with whitish hairs (64). They appear in axils of developing leaves, either single and sessile or as many as five or six on a short stalk up to 2 cm (0.8 in) long. Two flowers are often located at the base of the stalk and several along and at its tip. Basal flowers may be open while others on the stalk are still tiny and tightly closed. Flower openings are narrow; the interior elements are greenish to yellowish. Flowers were found on new growth that had extended only 1 cm (0.4 in) or up to 12 cm (4.7 in); most flowers were on new growth 4 to 7 cm (1.6 to 2.8 in) long. Flowering appears at its fullest when the first leaves are about half size; when leaves approach full size, catkins are withered. On a single tree, flowering seems to be a short event, perhaps a week long, as leaves develop quickly once growth starts.

Individual trees are known to flower abundantly, but observations are needed on the regularity of flowering and on the variability within and between stands and locations.

Seed Production and Dissemination- Seed crops may be heavy but are considered irregular. The large acorns, typically about 3 em (1.2 in) long and half as wide, mature in one season and ripen from late August to November. The age when a tree first bears fruit, the age of maximum production, and the average quantity produced have not been determined. In one collecting effort, about 18 kg (40 lb) of acorns per hour could be hand-picked from the ground under woodland trees between Redding and Weaverville, CA. The yield was estimated to be 5 to 9 kg (10 to 20 lb) each for trees 3 to 9 in (10 to 30 ft) tall and 15 to 30 cm (6 to 12 in) in diameter; production for this fair crop was about 560 kg/ha (500 lb/acre) (81). Northeast of Mount Shasta, a fair crop the same year yielded about 23 kg (50 lb) of acorns from a single tree 8 in (25 ft) in height and crown spread. In the Willamette Valley, acorns were dispersed from September to November, and three crops ranged from failure to 1737 kg/ha (1,550 lb/acre) ovendry-weight basis (12). Large crops of acorns are also produced by shrubby forms of Oregon white oak, but density of the stands can make collection difficult.

The heavy seeds disseminate by gravity only short distances from the tree crowns, except on steep slopes. Local transport is attributed primarily to the food-gathering activities of animals. In the past, Indians-and also pigeons-may have been responsible for long-distance colonization of Oregon white oak (28,71).

Seedling Development- Acorns of Oregon white oak must be kept moist until they germinate. In nature, moisture is maintained by a layer of leaves or through shallow insertion into soil from impact, rodent activity, animal trampling, or other soil disturbances. A moisture content of 30 percent or more must be maintained in cool regulated storage to maintain seed viability. Storage conditions have not been determined specifically for Oregon white oak; several methods recommended for keeping seeds moist should be suitable (46,65).

The acorns are large and heavy, averaging about 5 g each (85/lb). Viability has been better than 75 percent in the few samples tested (46), but the usual quality of the seeds is unknown. The seeds are not dormant; they will germinate soon after dispersal if subjected to warm, moist conditions. They will also germinate prematurely in low-temperature stratification. Normally, seeds retain viability only until the next growing season; chances of extending the viability period have not been determined.

Seedlings of Oregon white oak generally appear in the spring. Germination is hypogeal, and the rapid development of a deep taproot is believed responsible for their ability to establish in grass. Shoot development is relatively slow but can be greatly accelerated with long photoperiods (43). Seedlings are not produced now for forest plantings, but raising them in containers is readily possible. Direct seeding of acorns should also prove successful if seeds and young seedlings are protected from rodents and other predators. In at least some circumstances, natural reproduction from seed seems to occur readily (13,28,35).

Vegetative Reproduction- Oregon white oak sprouts abundantly from dormant buds on cut stumps, root collars, and along exposed trunks. Sprouts provide the most certain way to obtain natural regeneration. In 3 years, stump sprouts in 49 clumps in northwestern California averaged 10 per clump; height of the tallest sprout averaged 2.8 in (9.2 ft) and crown diameter per clump 2.5 in (8.2 ft) (52). Larger stumps produced more sprouts, larger clumps, and faster growing shoots. The spread of Oregon white oak by root sprouts has been noted in widely separated instances (28,68,69,70,71,74). In general, the rooting or layering of oak cuttings is difficult, and there is no reason to believe that Oregon white oak would be easier to reproduce by these methods than other oaks.

Sapling and Pole Stages to Maturity

Growth and Yield- Under favorable conditions, mature Oregon white oak trees are 15 to 27 in (50 to 90 ft) tall and 60 to 100 cm (24 to 40 in) in d.b.h. (34,48,72,73). A maximum height of 36.6 m (120 ft), crown spread of 38.4 in (126 ft), and diameter of 246 cm (97 in) at d.b.h. are on record (2,35). Typically, open-grown trees have short holes bearing very large, crooked branches that form dense, rounded crowns (fig. 3). Such trees occupy much space but do not produce much volume for commercial use, except for fuel. In contrast, forest-grown trees 70 to 90 years old have slim, straight holes, fine side branches, and narrow crowns (60). Trees measured in northwestern California had average form classes of 63 and 68 (34). Branchwood of trees over 60 cm (24 in) in d.b.h. averaged 24 percent of total cubic volume. Trees of better form are probably developing now because young stands are more even aged and better stocked than those in the past, but such stands are limited in extent and widely scattered.

Resource inventories of various intensities indicate that the Oregon white oak type occurs on at least 361 400 ha (893,000 acres) in California, Oregon, and Washington and, as a species, comprises 26.2 million in' (926 million ft') or more of growing stock (7,8,9,10,21,25,26,27). As a component of woodland and other vegetation types, Oregon white oak is found on an additional 299 100 ha (739,000 acres) in California and in sizeable, undefined areas in Oregon and Washington. In California, the mean stand growing-stock volume in the type was 76.9 m^3/ha (1,099 ft^3/acre), and the maximum found was 314.7 m^3/ha (4,498 ft^3/acre).

Oregon white oak generally grows slowly in both height and diameter, but there are exceptions. Limited data from widely separated locations indicate that six to eight rings per centimeter (16 to 20/in) is a common rate for slower growing Oregon white oaks (28,68,72,75). For example, trees in a full stand 47 to 70 years old on deep Willakenzie soil at Corvallis, OR, averaged 14 in (46 ft) in height, 15 cm (6.0 in) in d.b.h., and eight rings per centimeter (20/in) in radial growth (38). Oregon white oak has the capability, however, of growing faster than five rings per centimeter (13/in) (31,48,72,80). In the Cowlitz River Valley, the fastest rate shown on large stumps was 1.9/cm (4.9/in); in the Willamette Valley, the rate averaged 4.6/cm (11.8/in) for four forest-grown trees 95 to 135 years old that averaged 24 in (80 ft) tall and 48 cm (19 in) in d.b.h.

Basal area of Oregon white oak stands has ranged from 8.0 to 60.8 m^2 /ha (35 to 265 ft^2/acre), with up to 19.3 m^2/ha (84 ft^2/acre) additional basal area of other species present.

In these and other stands averaging 10 cm (4 in) or more in d.b.h., number of oak stems ranged from 10 to 2,800/ha (4 to 1,133/acre) (1,4,31, 62,69,70,72,75). Volumes for stands on different sites and of different ages are not known. One 80-year-old stand that averaged 160 trees 9 cm (3.6 in) and larger in d.b.h. would yield about 94.5 m^3/ha (15 cords/acre) (60).

Rooting Habit- Oregon white oak has a deep taproot and a well-developed lateral system; it is very windfirm even in wet areas. Fast taproot extension and sparse development of laterals are shown by seedlings in the first few weeks of growth. Despite formation of a deep taproot, a high percentage of oak roots are found in upper soil layers. Only 11 percent of the total number of oak roots were found below 76 cm (30 in) in deep Willakenzie soil (38). In contrast, 28 percent of the total Douglas-fir roots in the same soil were found below 76 cm (30 in).

Reaction to Competition- Oregon white oak has been classed as intermediate in tolerance, intolerant, and very intolerant of shade (47). Perhaps such a range of tolerance best describes its status in different situations. Clearly, it is not tolerant of over-topping by Douglas-fir and associated conifers. Dead oaks often found beneath Douglas-fir canopies bear witness that they could not endure the shade (40,72). In some locations and situations, Oregon white oak perpetuates itself, indicating that it can reproduce adequately in its own shade. Branch development on open-grown trees may be very dense. Sparse development of side branches in closed stands provides evidence, however, that it should be classed as intolerant of shade.

Oregon white oak functions as both a seral and a climax species. It is long lived, reproduces from both seeds and sprouts, forms nearly pure stands, and can endure great adversities. In fact, it rates as a climax species because it has greater ability than other species to establish itself and persist where yearly or seasonal precipitation is sparse, where soils are shallow or droughty, or where fire is a repeated natural occurrence.

Geologic and floristic evidence indicates that Oregon white oak associations have evolved through successive eras as components of relatively and pine-oak forests, have repeatedly advanced northward from a locus in the southwestern United States and northwestern Mexico, and have repeatedly retreated as North American climates warmed and cooled (16). The most recent northward advance ended about 6,000 years ago; the more and vegetation types, including oak woodlands, are now being replaced by conifer forest favored by the climatic trend toward cooler and moister conditions.

The seral role of Oregon white oak is illustrated by major changes occurring in the Willamette Valley. Open oak woodlands, savannas dotted with oaks, and grasslands were prominent and widespread before the territory was settled; fires-natural as well as those set by Indians-maintained these open conditions (30,31,36,44,61). Post-settlement exclusion of fire permitted development of closed-canopy white oak stands that are typically of two ages-large spreading trees, now 270 to 330 years old, are scattered among smaller trees of narrow form, 60 to 150 years old (73). Where not restricted by agricultural practices, young oaks continue to encroach into grassland. But, in turn, many oak stands are being invaded and superseded by bigleaf maples or conifers, mainly Douglas-fir (fig. 4). A similar sequence of events is occurring in the northern oak

woodland, a distinctive Oregon white oak type in California (5,51,69). Unless steps are taken to reverse present trends, the Oregon white oak type will continue to become a less prominent part of the western flora. A reduction in species diversity will also occur, for open-canopy communities have a more varied composition than closed conifer communities (13).

Damaging Agents- Because of their attractiveness as food, seed crops of Oregon white oak are often decimated quickly (12). Larvae of the filbertworm *(Melissopus latiferreanus)* and the filbert weevil *(Curculio occidentalis)* damage crops even before acorns ripen (23). Maturing or ripe acorns are consumed by woodpeckers, pigeons, doves, jays, wood ducks, mice, chipmunks, squirrels, pocket gophers, woodrats, deer, bear, and other wildlife, as well as by domestic animals.

Wind, wet snow, and freezing rain damage Oregon white oak less than associated hardwoods, but in tests it showed only moderate resistance to cold. Dormant buds collected northwest of Corvallis, OR, withstood -15° C (5° F) and twigs -20° C (-40 F) without injury (55).

Large Oregon white oaks are obviously fire resistant; they have withstood annual or periodic fires for years. But small oaks may be killed or badly damaged by fire, as evidenced by the increased density and spread of oak stands since the advent of fire control.

More than 110 pathogens have been found on the leaves, twigs, trunk, or roots of Oregon white oak (59). Most are of minor consequence; many are saprophytes. Leaf-spot, mildew, and anthracnose fungi sometimes attack the foliage, but control methods have been suggested for only one-an anthracnose disease *(Gnomonia quercina).* In 1968, this fungus caused moderate to severe dying of leaves and possibly death of oak trees in southern Pierce County, WA (14). Premature browning of foliage is occasionally widespread in the Willamette Valley, but the causes and effects have received only incidental attention. The hairy mistletoe is common on Oregon white oak in Oregon and California, forming conspicuous, rounded growths in the upper crown. Its effect on growth and vigor of this host is undetermined. The white pocket root and butt rot (Polyporus dryophilus) and the shoestring root rot *(Armillaria mellea)* are probably the most damaging rots found in Oregon white oak. Its heartwood is generally very durable; stumps and even relatively small stems may remain intact for years.

Although Oregon white oak is host to hundreds of insect species (19), damage is usually not severe, and loss of trees to insect attack is uncommon. The western oak looper *(Lambdina fiscellaria somniaria)* is probably the most damaging insect on white oak from Oregon north to British Columbia. In some years, oaks over large areas in the Willamette Valley are defoliated (23). The damage is temporary since the trees leaf out the next year and outbreaks are not sustained. The western tent caterpillar *(Malacosoma californicum)* and the Pacific tent caterpillar *(M. constrictum)* are widely distributed defoliators with a preference for oaks. Several species of aphid, particularly *Teberculatus columbiae,* feed on the underside of oak leaves; the snowy tree cricket *(Oecanthus fultoni)* lives in open-grown oaks and associated species; and several leafrollers *(Abebaea cervella* and *Pandemis cerasana)* are found on Oregon white oak. Oregon white oak is

the principal host for *R. cerasana*, an introduced leafroller causing sporadic defoliation that is now maintaining a relatively high population and slowly extending its range around Victoria, BC (17). Many gall wasps are found on oaks; those prominent on Oregon white oak include *Andricus californicus*, which forms large, persistent, applelike galls on twigs; *Bassettia ligni*, which causes seedlike galls under the bark of branches that often girdle and kill the branch; *Besbicus mirabilis*, which forms mottled, spherical galls on the underside of leaves; and *Neuroterus saltatorius*, which forms mustard-seed-like galls on lower leaf surfaces that drop in the fall and jump around like Mexican jumping beans caused by activity of the enclosed larvae (18,23).

Only incidental damage by animals has been noted on vegetative parts of Oregon white oak. Douglas squirrels and western gray squirrels sometimes debark small branches infested by gall wasp larvae (64). Damage is scattered and may involve as much as one-fourth of a tree's crown. Gophers and other burrowing animals, which are abundant on forest borders, damage some roots. Livestock inflict some trampling and feeding damage on young oaks.

Special Uses

The wood of Oregon white oak is dense, with specific gravity ranging from 0.52 to 0.88 when ovendry (66), has moderate strength in static bending tests, but does not absorb shocks well (47). It rates high in compression and shear strength and is outstanding among 20 northwestern woods in tension and side hardness tests (47). The heartwood is at least as durable as that of white oak *(Quercus alba)* (58). Pallets made from Oregon white oak compare favorably in strength with those made from other species (66) and are higher in withdrawal resistance for nails or staples (41).

Specialty items, fenceposts, and fuel are now the primary uses of Oregon white oak. The wood is considered one of the best fuels for home heating and commands top prices. It has been used for flooring, interior finish, furniture, cooperage staves, cabinet stock, insulator pins, woodenware, novelties, baskets, handle stock, felling wedges, agricultural implements, vehicles, and ship construction (60). Consumption of Oregon white oak totaled 12 454 m^3 (2,185,000 fbm) exclusive of fuel in 1910 but has since declined (60).

Although Oregon white oak is not grown commercially for landscape purposes, scattered native trees, groves, and open stands are highly valued scenic assets in wildland, farm, park, and urban areas (35,42,49,56). Mistletoe is a scenic growth on Oregon white oaks that is collected and sold as a decorative and festive minor product.

Until recent times, meal or mush made from acorns of many oaks (including Oregon white oak) was a common Indian food (35,71,81). When crops were heavy, white oak acorns were also gathered and stored by local ranchers for feed, mainly for hogs. Livestock forage for acorns and prefer those of white oaks to black oaks (81). The leaves have a protein content of 5 to 14 percent (35,56), and Oregon white oak is rated as good to fair browse for deer but poor for domestic livestock.

Oregon white oak woodlands and forests provide favorable habitat for wildlife (6) and also produce substantial amounts of forage for sheep and cattle (33). Infrequently, cattle

are poisoned by foraging on oak; one instance involving Oregon white oak has been documented (37).

Oak-dominated forests in the western part of the Willamette Valley in Oregon have a higher diversity of birds in all seasons than adjacent conifer forests (3). Oregon white oak and ponderosa pine-Oregon white oak associations are preferred brood habitats for Merriam's wild turkey in south-central Washington (39).

Greenhouse experiments have shown that Oregon white oak is a good host for the gourmet truffle, *Tuber melanosporum* (43). The feasibility of managing Oregon white oak stands for truffle production, as many oak stands are managed in Europe, is being investigated.

Genetics

Though Oregon white oak populations in Washington are disjunct and scattered, the chemical and morphological characteristics of their foliage are similar (71). Genetic differences appear so minor that seed distribution from a common source by Indians has been postulated. Ecotypic variation was observed in top and root growth of young seedlings from seed collections made from Corvallis, OR, southward (43). First-year seedlings from northern sources were taller and heavier.

Quercus garryana hybridizes naturally with four other oaks. *Quercus x subconvexa* Tucker *(Q. durata x garryana),* a small tree found in Santa Clara and Marin Counties, CA, is noteworthy because of its morphologically dissimilar parents-*Q. garryana* is a deciduous tree, *Q. durata* an evergreen shrub, and the hybrid is tardily deciduous (74). *Quercus* x *howellii* Tucker *(Q. dumosa* x *garryana)* is also a small tree found in Marin County and a hybrid between a deciduous tree and an evergreen or tardily deciduous shrub or tree. *Quercus* x *eplingii* C. H. Muller *(Q. douglasii* x *garryana),* a tree with deciduous leaves, is found in Lake and Sonoma Counties, CA (75). Hybrids between *Q. garryana* and *Q. lobata* are also found in Sonoma County (4).

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Pacific Madrona Management (*Arbutus menziesii*)

Source: Lincoln Park Vegetation Management Plan (SPR 2002) - David Bergendorf

The Pacific madrona (*Arbutus menziesii*) Pursh is a favorite tree of many Seattle residents. Urban populations of Pacific madrona in Seattle Parks have shown increasing signs of disease in the last thirty years. Fungal pathogens such as *Natrassia mangiferae* and *Phytopthora* species are major causes of decline in individual trees. Recent research indicates that a relationship exists between the decline of madrona trees, microclimate, site characteristics, and fungal pathogens. The results of research point to specific best management practices.

Specific recommendations for managing madrona trees are presented below. A review of current literature pertaining to management of Pacific madrona trees follows, with references.

- ***Soils surrounding the root zones of Pacific madrona trees should be managed to reduce the effects of soil compaction.*** This should include eliminating ongoing soil compaction and mitigating existing soil compaction. At least 4 inches of coarse woody mulch should be spread on top of Pacific madrone root zones to prevent further compaction. Care should be taken not to pile mulch against the stem of individual trees. If soils are already compacted an air spade can be used to loosen the soil before adding a layer of coarse woody mulch.

- ***Fertilizers should not be added to the root zones of Pacific madrona trees.*** Fertilizers can disrupt the mycorrhizal associations between beneficial fungi and roots of Pacific madrona trees. Disrupting this mycorrhizal relationship can reduce the supply of water and micronutrients to trees. Changing the balance of micronutrients may influence disease caused by foliar pathogens such as *Natrassia mangiferae*. Trees without healthy mycorrhizal associations will also become susceptible to fungal pathogens such as *Phytopthora* species. Elliott et al. (2000) found a significant decrease in mycorrhizal diversity of Pacific madrone roots as nitrogen in the soil increased.

- ***New Pacific madrona trees should only be introduced into sites with well-drained soil and full sun exposure.*** In nature, regeneration of Pacific madrona trees occurs after major disturbances such as fire or clearcutting, which results in full sun exposure. The ideal size for planting is in 1gallon pots, or smaller. Research has shown that the ideal size to transplant madrona trees in landscapes is as small as possible, since they survive best where they can establish roots first, then begin to develop above ground biomass.

- ***Fungicides should not be applied to the root zones of Pacific madrona trees.*** Fungicides can kill beneficial mycorrhizal fungi, which protect tree roots from pathogens.

Natural distribution

The Pacific madrona has a natural range that stretches form the east coast of Vancouver Island southward to San Diego, California. Madrones occur in areas that have experienced some disturbance due to logging, fires, or other activities that lead to open patches in the canopy (Kruckeberg 1996). They also occur in canyons (Whitney 1998), prairie edges, at the transition zone of water bodies, on upland slopes (Whitney 1998), cliff sides, on mountain slopes higher than 3,000 feet above sea level (Burns and Honkala

1990), and on bluffs or ridges often near salt water (Dirr 1998). Native soils occur in a wide range of textures, are often rocky and many are less than 1 meter deep. A common native soil characteristic is good drainage and low moisture retention in the summer (Burns and Honkala 1990). According to Adams et al. (1999) Pacific madrona will do best in well-aerated, well-drained sandy loam texture soils.

Rooting habit of Pacific madrona

Burns and Honkala (1990) found that two to five year old seedlings showed large variation in rooting pattern and length. Some seedlings had a curving primary root with moderate lateral development and others had moderately twisted primary roots that straightened out just below ground line and grew straight downward to a depth of twenty-three centimeters. Pelton (1962) found larger root systems present on seedlings in sunny sites, except when attacked by fungi. He also observed an absence of root hairs on seedlings and that damage to root tips stimulated branching.

Large uprooted trees suggest a root system composed of deep, spreading lateral roots (Burns and Honkala 1990). Zwieniecki and Newton (1995) examined the morphological adaptations of A. menziesii roots growing in rock fissures. They found roots in fissures as small as 100μm, as estimated by root thickness. Roots growing in narrow fissures developed flattened cortex tissue, and were ribbon like in shape. No normal root hairs were found on such flattened roots.

Mycorrhizal associations

Mycorrhizae are beneficial for roots of Pacific madrona trees. Roots of many plant species commonly form symbiotic associations with soil dwelling fungi. These root-fungi associations are called mycorrhiza (Trudell et al. 1999). Most of the dominant plants in boreal coniferous and temperate deciduous forest ecosystems form ectomycorrhizal associations, often with basidiomycetes (Read 1982). In many cases of mycorrhizal symbiosis the fungus involved enhances plant access to nutrients from the soil, increases rootlet size and longevity, translocates water to the plant and protects the rootlets from many pathogens (Killham 1994). There is evidence that ectomycorrhizal fungus can exert direct antibiotic effects upon pathogenic organisms. In all cases studied nutrients are transferred from the fungus to the plant roots across an interface. In most mycorrhizae organic carbon, fixed by photosynthesis, is transferred from the plant to the fungus. Mycorrhizae can immobilize toxic heavy metal such as zinc, cadmium, and manganese. They can improve soil structure by facilitating binding of soil aggregates (Coyne 1999).

Limited research on the optimal pH for growth of ectomycorrhizal fungi indicates that they grow best in the pH range of 3-5 (Smith and Read 1997). Mycorrhizal colonization is strongly influenced by concentrations of soil nutrients. High levels of soil nitrogen and phosphorous can inhibit the formation of mycorrhizal associations (Killham 1994). Increased inputs of sulfur and hydrogen ions as a wet deposition can have adverse effects on both partners in the mycorrhizal association (Smith and Read 1997). Fungicides applied to soils are toxic to mycorrhizal fungi. Other management practices such as

tilling and burning vegetation can kill mycorrhizal spores in the soil. Mycorrhizae fungi are obligate aerobes so poor drainage and waterlogged soil limits mycorrhizal population size (Coyne 1999). Excessively low soil water levels also reduce mycorrhizal development possibly due to water stress on both the plant and fungal partner, or to changes in nutrient availability resulting from water stress (Killham 1994).

Roots of Pacific madrona trees form a type of mycorrhiza termed arbutoid. According to Trudell et al. (1999) arbutoid mycorrhizae form sheaths around root tips, of the host plant, and enters the cells of the roots forming thin coils. Smith and Read (1997) speculated that arbutoid mycorrhiza may serve the dual purpose of storage and to separate the plant from the soil. The Pacific madrona has been shown to form associations with basidiomycetes. Fungal associates of Pacific madrone can form ectomycorrhizae with other plant species (Smith and Read 1997). Trudell et al. (1999) found that A. menziesii trees growing near Douglas firs associate with a greater diversity of mycorrhizal fungi than trees not near Douglas firs and that they associate with many of the same mycorrhizal fungi.

Special adaptations

Tappeiner et al. (1986) report that Pacific madrone trees can sprout from burls, when their stems have been damaged. Burls are globe like structures of adventitious buds located below ground at the base of stems. They found that sprouted clump dimensions could be accurately predicted from parent stem diameter and time since cutting.

James (1984) described how perennial shrubs of the California chaparral, and plants found in other Mediterranean-type ecosystems, sprout after injury from an ontogenetically produced swollen stem base/root crown that she called a lignotuber. She differentiated burls from lignotubers in that the former often refers to woody tissue developed around stem wounds on trees and shrubs. Lignotubers are different in that they may serve as carbohydrate and nutrient sources and they are produced through gene expression and not as a result of injury. Lignotubers can produce stem or root sprouts from dormant, protected buds enabling repeated shoot production despite frequent fire damage. After injury of the plant canopy, the hormonal influence of apical dominance is removed and dormant buds develop into new stem or root tissues.

Vegetative regeneration is adaptive under conditions of stress such as fire and drought because it provides a mechanism for rapidly replacing foliage between fires and after droughts. Plants that are “sprouters” also tend to develop a deeper root system. The advantages conferred by a lignotuber are adaptive for plant species that have evolved to endure fire, such as A. menziesii (Edmonds et al. 2000).

Propagation

Pacific madrona fruits ripen in September and will remain on the tree until December. Seed-source berries can be collected from October to December. Berries should be dried or macerated to remove pulp from the seeds (Rose et al. 1998). Eight seeds can be

obtained from each fruit (Gonzalez 1999). Dried berries or seeds can be stored at room temperature for one or two years (Roy 1974).

Hartman et al. (1997) advise cold stratification of seeds, at 2 to 4° C for two to three months after which the seeds can be started in flats. Seeds can also be stratified naturally outdoors over winter, in western Washington (Rose et al. 1998). Seeds can be germinated in flats with an equal mixture of peat and loam soil (Kruckeberg 1994), in a sand-peat medium (Rose et al. 1998) or in a fine seedling mix (Gonzalez 1999). Seedlings should then be placed in a warm, well-lit place. Seeds will begin to germinate in two weeks. After at least two or four true leaves appear the seedlings can be transplanted (Gonzalez 1999).

Seedling survival

Seedlings are difficult to transplant and should be planted in a permanent location when less than forty-five centimeters tall (Hartman et al. 1997). A. menziesii seedlings are slow growing (Burns and Honkala 1990), (Rose et al. 1998). Winters and Hummel (1999) transplanted seedlings from one-gallon and three-gallon pots into landscapes. After four years, they found that the plants were of similar size even though the three-gallon plants had been larger at the time of planting. In natural settings seedlings tend to become established on disturbed sites, on bare mineral soil or in semi-open forests (Burns and Honkala 1990). Shoffner (1999) found that light level had the greatest effect on seedling growth. Plants growing in full sun with weekly irrigation accumulated most biomass and maintained the highest rates of photosynthesis, despite moderate water stress.

Pests and Diseases

Many insects are known to attack Pacific madrona. A list of insect species known to feed on Arbutus menziesii is displayed in Table A-1. Environmental stresses that facilitate infection by fungi can reduce overall resistance of trees and allow insects to become established as well as disease (Trudell et al. 1999).

Pacific madrona trees are susceptible to attack by wide range of fungi. A list of fungal species that are known to cause disease in A. menziesii is displayed in Table A-2. Cracking due to sunscald or mechanically induced wounds can facilitate colonization by canker and decay fungi (Elliott 1999). According to Elliott (1999) environmental factors such as excess shade, regular watering and fertilization may predispose trees to successful attack by pathogenic organisms. Hunt (1999) suggests that root disturbance can stress A. menziesii trees and predispose them to attack by fungi such as *Phadcidiopycnis spp.*, which is not pathogenic to healthy trees. Trees that have grown up in shade often have a spindly growth form that may predispose them to canker diseases if adjacent shade trees are removed (Bressette and Hamilton 1999).

Scientific name	Common name	Author
(many)	aphids	(Dreistadt et al. 1994)
Aleuropleurocelus nigrans	black aleyrodid	(Johnson and Lyon 1991)
Chrysobothris mali	flathead borer	(Dreistadt et al. 1994)
Coccus hesperidum	brown soft scale	(Dreistadt et al. 1994)

Coptodisca arbutiella	madrona shield bearer	(Dreistadt et al. 1994)
Euphyllura arbuti	madrona psyllid	(Dreistadt et al. 1994)
Gelechia panella	blothch leaf miner	(Dreistadt et al. 1994)
Hemiberlesia rapax	greedy scale	(Dreistadt et al. 1994)
Hyphantria cunea	fall webworm	(Johnson and Lyon 1991)
Lithocolletis arbutisella	blotchminer	(Elliott 1999)
Malacosoma californicum pluviale	western tent caterpillar	(Johnson and Lyons1991)
Marmara arbutiella	leafminer	(Dreistadt et al. 1994)
Trialeurodes madroni	madrona whitefly	(Dreistadt et al. 1994)
Wahlgreniella nervata	manzanita aphid	(Johnson and Lyon 1991)

Table A-1 Insects known to attack Pacific madrona

Scientific name	Common name	Author
Aleurodiscus diffisus	smooth patch	(Sinclair et al. 1987)
Armillaria spp.	white rot	(Elliott 1999)
Ascochyta hanseni	leaf spot	(Elliott 1999)
Botryosphaeria dothidea	(none)	(Sinclair et al. 1987)
Coccomyces quadratus	tar spot	(Elliott 1999)
Coniothyrium spp.	leaf spot	(Sinclair et al. 1987)
Cryptostictis arbuti	leaf spot	(Elliott 1999)
Didymosporium arbuticola	leaf spot	(Elliott 1999)
Diplodia maculata	leaf spot	(Elliott 1999)
Disaeta arbuti	leaf spot	(Elliott 1999)
Elsinoe mattirolianum	spot anthracnose	(Elliott 1999)
Exobasidium vacinii	leaf blister	(Byther 1999)
Formitopsis cajanderi	brown tip rot	(Elliott 1999)
Fusicoccum aesculi	asexual stage of B. dothidea	(Elliott 1999)
Heterobasidion annosum	Annosum root rot	(Sinclair et al. 1987)
Mycosphaerella arbuticola	leaf spot	(Pscheidt and Ocamb 2001)
Phellinus igniarius complex	white rot	(Sinclair et al. 1987)
Phyllosticta fimibriata	leaf spot	(Elliott 1999)
Phytophthora cactorum	root rot	(Sinclair et al. 1987)
Poria subacida	yellow root rot	(Elliott 1999)
Pucciniastrum sparsum	Rust	(Elliott 1999)
Pythium spp.	damping off	(Elliott 1999)
Rhytisma arbuti	tar spot	(Sinclair et al. 1987)

Table A-2 Fungal pathogens known to attack Pacific madrona

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IVY REMOVAL PROJECT

Headquartered at Forest Park in Portland, Oregon

Ivycide Clues, Removal Formulas, Weapons of Choice and Control Techniques

Compiled by Bruno Precciozzi
May, 2003
Forest Park Ivy Removal Project

We receive frequent requests from private property owners, both residential and commercial, for methods and means to be rid of English Ivy. The phone calls, letters, emails, and drop-in visits to our Ivy Removal Clinics has increased to the level that we have been unable to respond to individual requests as quickly and as thoughtfully as we'd like. Thus, we decided to collect ideas and suggestions from several sources.

Our virtual volunteers combed gardening bulletin boards and other internet opportunities for sharing ideas. Many Ivy Busters associated with our project offered formulas for de vine intervention. Fearsome No Ivy Commandos revealed their weapons of choice. We often found similar suggestions and have melded those together. We also found some rather unique approaches.

But!! Here's the truth we found in the "I"-files. Just like we have found by our work in natural areas and public lands, there is no silver bullet to "exorcise" this invasive creature. Different techniques seem to work better for different folks, However, one resounding "truth" has been found that can be expressed in this formula: persistence + vigilance = control. What! No eradication?! Well, that will take community wide efforts to stop ivy seed production, stopping any new introductions to the landscape, and ivy free neighbors who would never dream of letting the ivy escape by root, by vine, or by seed into someone else's property.

We also have sets of recommendations under Control Methods on our web site: http://www.noivyleague.com/Pages/cont_assess.html or go to www.noivyleague.com then access control methods from the navigation bar. Check these out, too!! Especially check out the sections on lifesavers, log rolls, and donuts on the slope. User note: Since this information will be used for both email and postal mail as well as other methods of distribution and posted under what's new on the web site, the cross references above are given.

If an Ivycide clue below is unattributed, it represents a summary of similar ideas expressed in different locations and formats. Should any individual feel that his/her idea is used without appropriate attribution, please contact us so that we can take correction action. However, we hope all who have pursued ivycide would cheerfully share any good idea with fellow No Ivy

Legionnaires valiantly engaging in hand to vine combat!!

Special Reminders

Ivy is not a parasite. It does not root into a tree or feed off a tree. It receives nutrients and water from its roots.

When ivy is girdled (All vines growing up a tree are cut and thus separated from its roots) the leaves above the girdle will brown out and the upper vines will eventually fall off on their own. Pulling vines down from the upper reaches of a tree can damage the tree or bring down branches or the tree itself.

Ivy has two stages: juvenile and adult. The leaves and growth habits are remarkably different. Some people think adult (mature or arborescent) ivy is a different plant. Click here to see the photos to know the difference.

While ivy often grows up trees or structures to receive more light for maturation and seed production, ground cover ivy can also mature and produce seed. Stopping seed production is the highest priority. Remember, " Don't harbor the seeds of destruction, please cut your bloomin' ivy!"

Manual/Mechanical Removal

Ivy League Note: Simply pulling ivy is an ineffective method of removal as the vines typically snap leaving viable vine stubs and an aggressive root system behind in the ground. Ground removal techniques must focus on removing as much of the root as possible. Terrain, density and depth of the ivy mat, time of year, and physical extent of the infestation necessitate alternate techniques. Mechanical assistance can accelerate and increase thoroughness of removal depending upon the maturity and savvy of the workers. Also, Ivy roots are easier to remove when the ground is moist. If it is a drier season, we recommend wetting the area with a garden hose.

If you have a large area covered with ivy, set priority areas for removal because you probably won't be able to do it overnight. For example, select an area for a garden plot and clear that. Then expand from there.

Many people use a mechanical methods such as hand pulling, raking, weed eating, mowing, or a combination of these then placing either black plastic, newspaper, several inches of mulch for an extended period thus preventing sprouting of residual vines and roots. Dramatic reduction of ivy biomass followed by light deprivation has been reported successful on slopes.

"I've had some success mowing the stuff.
Mow it once with the mower at its highest setting to get the leaves off.
Then mow again at the lowest setting to chew up the vines.

NOTE: This does *awful* stuff to your mower blade, be prepared to replace it sooner than normal.
Mowing and then laying cardboard over it would also probably help, since it would be easier to get the cardboard down in contact with the soil."
(-- Contributor)

"I've found that mulching over ivy is a wonderful way to build an ivy bed. Mechanical destruction is the only positive and sure way to do it.
The mower idea is a great one. I've used it to keep one area under control for years. Zero growth beyond the edge of the lawn."
(-- Contributor)

"You can clip the ivy around the tree at its base, then the stuff up the tree will die. It has to be done annually, and it doesn't look too good, but it will keep the tree from being shaded. I do this every year to a couple of trees that get the ivy from neighbors and have been successful in pulling out the previous year's growth. Also, ivy is surprisingly easy to yank out of the ground if it is the only thing growing. I once lived in a house where the entire front yard was planted with ivy, and I yanked it all out quite easily."
(--Sybil Nelson)

The method that has had the most success in the Eugene area begins in late summer: first collect some native seeds if there are any in the work area, then whack off the ivy stems when any struggling natives mixed in are dormant. Compost the stems, or they may resprout if left on the groun. Then, when it rains and softens the soil, follow with digging out the root wads. Remaining root fragments will sprout, so it will take some mop-up work for at least a couple of years to catch those. The rebound of the natives has been very astonishing in some places. They may be hiding out under the ivy. Supplemental seeding with natives where the roo wads were dug up may be desirable, as weeds are encouraged wherever thre is soil disturbance.
(-- Isabel Tipton)

Chemical Controls
Many people have suggested using a combination of mechanical and chemical methods to remove the ivy. An example of this would be to first wound the ivy with a lawn mower or a weed-eater, and then to apply herbicide to the wounded ivy.

"What I have done is to test some ways to ways to kill the roots. The most promising result has come from abrading a few leaves on the large plant with fine sand paper and spraying with Roundup. I cut off all of the foliage on all of the plants a few weeks after treating them. All of the plants sprouted again. The abraded plant sprouted very weak growth with small,

oddly shaped leaves. It has grown very little in over a year. I have allowed all of the plants to grow, but plan to remove the foliage again. One certain way to kill ivy is to to keep the leaves cut off. It does eventually die if continually pruned back."
(-- Jim Brown of Portland, OR)

"It is easy enough to kill by sawing through the thick stems, sometimes up to 15cm in diameter on big old plants, and painting the cut with glycophosphate within one minute of making the cut. This will cause the plant to die over the next few weeks. A follow up check should be made in case a few stems were missed. If the plant is growing in soft soil it should be pulled up roots and all. Every piece of the vine should be removed as it can regrow."
(-- Contributor)

"I have some experiences with Roundup and ivy and other like plants. Roundup, even tiny smatterings of it which drift onto foliage of plants, trees, and shrubs can and will kill them. Growth must be new and vigorous for roundup to really work well. Cutting the ivy back to 'green' it before spraying will work, but any plant will die quicker and more thoroughly during its annual maximum growth period. Roundup works fine alone. 2-4-D has no place in the environment. Period. "
(-- Contributor)

"I like to use a spray oil with Roundup, it helps it stick to the waxy surface of plants like ivy and I feel that it reduces runoff."
(-- Contributor)

"Hand pulling, rolling the plant back from the outer edges and cutting all roots as it is rolled back.
All stems should be removed as they can reestablish.
Spot spray with 4% Glyphosate 360 during when stored reserves are low, or high volume spot spray with Brushoff at 15g/100L plus 200mL Agral 600 (wetting agent)."
(-- Contributor)

"You can use an herbicide that contains dicamba, but only do so as a last resort, and then use caution to avoid damaging desired plants.
I would "paint" the herbicide on the ivy leaves rather than spray or you will be more likely to harm your azaleas and ferns."
(-- Contributor)

No Ivy League Note: When using herbicides be sure to read directions carefully and to follow them. Folks tend to use too much thinking if a little works, then a lot will work even better. WRONG!! Also think about what you don't want to harm and take appropriate cautionary measures.

Consider who or what has access to the area where you are using herbicides and think about what exposure may mean inadvertently. In other words, don't hate ivy so much that you use herbicides in a reckless or thoughtless way. Many people prefer not to use herbicides at all and prefer nor to be exposed to them. Be considerate and prudent if you decide that herbicide use is your best personal course of action.

Biological Control

Some people have put sheep and goats on small acreage with reported success in reducing the ivy significantly. However, no one has reported information about how this works for the long term. Caution is urged in thinking that all grazing animals can be put to pasture in an ivy bed. All parts of ivy are classified as toxic although some animals such as sheep and goats appear to be relatively unfazed by the toxins. There are reports of both deer and elk browsing on ivy but this may be more so due to loss of their habitat than a preference for ivy. Also, careful control of the sheep and goats is advised to prevent unwanted loss of desirable plants which may taste better to the animals. It is not generally believed that this is a method that can be used for large scale infestations or in more urban areas due to other issues related to the keeping of livestock. But, there are some situations where grazing animals can be very helpful in control and reduction.

Other Methods

Some people hire a landscaping company a landscape contractor, or an arborist to remove ground ivy and ivy growing on a tree. Note: There are many excellent landscapers and arborists. However, not all are reputable and not all are knowledgeable about invasive plants or proper removal methods. Do check references and their licenses. Landscapers and arborists have professional associations. These plus organizations like Native Plant Societies, Plant Amnesty, Naturescaping programs, and Extension Services can be good sources for referrals.

Others suggest hiring local youth much as the way youth are hired to do other yard work. Others have worked with youth groups and scout groups to remove the ivy as a service project especially when a person with an ivy problem has physical limitations or when they plan to "naturescape" thus provide better habitat for desirable wildlife. In the case of youth or scout groups, often a contribution is given to the organization or troop but food and beverages are recommended as part of the enticement and acknowledgement.

Yet others have had ivy removal gathering where neighbors, friends, or family works on the ivy removal then enjoys a great picnic or barbecue.

This is modeled after the barn-raising cooperation many communities have practiced.

“We have been attacking the ivy in Poison Oak areas by having staff wear Tyvek (hazmat) suits, using Tecnu with a cold shower immediately after and washing clothes in hot water. They are working in some pretty intense areas with aerial Poison Oak. There have been a few cases of them getting it but its pretty minor. Herbicide use here is problematic as we are with a very active anti-herbicide community . (Andrea Prickart of ...”

“The prunings can be disposed of in several ways:
Solarisation is probably the most environmentally friendly way. Put the prunings in a garbage bagand place in full sunlight for 6 weeks or so and the sun will cook it sufficiently so that the contents can be emptied on to garden beds as mulch.
Prunings put into a Hessian bag or the like and lowered into a bin of water and left to rot is another good way; it also gives you some excellent liquid fertilizer for your new garden bed and after 6 weeks or so the Ivy is a harmless mulch.
Put the garbage bag of prunings straight into the bin. Do not put it out with your green waste or it could be mulched and become millions of plants.
Hang the vines in a tree where they can dry out and become mulch.”
(-- Dale Morgan of the CRISP Nursery in Ringwood, Australia)
Special Note: Rotting plant material, especially wet, rotting, plant material, has a tendency to be somewhat odoriferous!

“No ivy has sprouted from my compost bin, and last summer ivy was my primary green.
But all that ivy was sent through the mower or chipper/shredder.
The pile got *hot*, 155 degrees F for several days at a time, which I think is what really did the trick.
The bare vines that I’m pulling up now I leave in a pile on the concrete drive way for a couple weeks”
(-- Contributor)

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Excerpts from
Removal Reminders
Thursday, February 15, 2001

By ANN LOVEJOY
SPECIAL TO THE POST-INTELLIGENCER

Several recent articles on ivy removal brought in a generous flow of reader responses. I'd like to share the best tips, some of which are real time

savers. I'm including a couple of horror stories in the hope that you all can avoid similar problems.

A reader on Vashon Island reports good results from mowing her ivy. She explains, "We decided to try mowing it a few years after the ivy had been planted (yes, planted, by a professional landscaper yet!). And it works! Now every 2 years we mow the bank of ivy in the fall with a mulching-mower, and that keeps the ivy down, under control, and tidy."

Where ivy covers a relatively flat area and you know what's underneath, mowing can be a good temporary control. However, in unfamiliar territory it's important to cut ivy (or any ground cover) ... [to] reveal any hidden hazards such as stumps, holes or rocks that can seriously damage expensive machinery

On steep slopes where mowing is dangerous, ivy can be trimmed with a weed whacker or brush cutter.

Trimming once each year will keep ivy in its juvenile state, which means it can't produce seeds. It can still get away from you quickly, however, and even a lapse of a few seasons can create an ivy wilderness.

You may well be responsible enough to keep the ivy under control. However, if you move or sell your home, the next person may not be so responsible and the potential problem will simply be passed along.

Mowing or trimming is an excellent way to control ivy temporarily. It should be supplemented by a staged removal program. Plan to replace the ivy slowly. Each time you hold a removal session, don't work for more than a few hours. For many people, more than a few hours of vigorous, repetitive action like pulling ivy can lead to problems. One reader reported that a prolonged session of ivy removal ended up in a torn shoulder (rotator cuff), an exquisitely painful experience I'd like to spare the rest of you.

Here's a little ivy removal reminder list:

* Warm up first, stretching and loosening all body joints.
* Actively pull ivy for no more than an hour, maybe less.
* Shake out hands and shoulders every 15 minutes.
* Take a break and do something totally different for half an hour.
* Remember that ivy removal can be done year round, so an hour a week is plenty.

To prevent regrowth [up a tree], pull as much ivy root from the ground as possible. After the trees are set free, spend an hour or two each week removing ivy from the ground. A small pick or mattock works beautifully for

this chore.

As I learned at Plant Amnesty workshops, two people can remove sheets of ivy quickly if one end is loosened with a sharp flat shovel. One person rolls the ivy back like a rug and the other chops the roots.

There will be some resprouting from this, but the reappearing ivy is quite manageable if you follow this simple program:

* Remove ivy as above.
* Heavily mulch each cleared area with shredded bark (4 to 6 inches). This depletes nitrogen from the soil as it breaks down.
* Monitor each area once a month and remove all visible ivy, taking as much root as possible. The deep mulch softens the ground, facilitating root removal.
* After a year, cover bark with three to four inches of compost and plant appropriate native plants and ground covers. (See the P-I Web site (www.seattlep-i.com) for my recent columns suggesting good alternatives to ivy.)

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BLACKBERRIES

Himalayan Blackberry *Rubus discolor*; Evergreen Blackberry *Rubus laciniatus*; Trailing Blackberry *Rubus ursinus*

Himalayan blackberry, evergreen (or cut-leaf) blackberry and trailing (or wild) blackberry are the three common blackberries in Whatcom County. Of these, only one, trailing blackberry, is native. The other two are both introduced plants which have become aggressive weeds here. Despite being troublesome weeds, neither Himalayan nor evergreen blackberry is on the Washington State Noxious Weed List. The weed list addresses plants for which there is a realistic chance of state or countywide control, and both these plants are so abundant that such control is unrealistic.

HIMALAYAN BLACKBERRY

THREAT: Himalayan blackberry is the most visible blackberry of Whatcom County, growing along roadsides, over fences and other vegetation, and invading many open areas. It is native to Western Europe and was probably first introduced into North America in 1885 as a cultivated crop. Himalayan blackberry is very aggressive, reproducing both vegetatively and through seed production and can displace native vegetation. Seeds can be spread by birds, humans and other mammals. Blackberries can form suckers off roots, and canes will root when they touch the ground, forming new plants. New plants will also readily grow from pieces of root or cane. Himalayan blackberry quickly forms impenetrable thickets, consisting of both dead and live canes.

DESCRIPTION: Himalayan blackberry is a robust, sprawling, weak-stemmed shrub. The stems, called canes, grow upright at first, then cascade onto surrounding vegetation, forming large mounds or thickets of the blackberry. While some canes stay more erect, growing up to 9 feet high, others are more trailing, growing 20-40 feet long. The canes can take root at the tip when they hit the ground, further expanding the infestation. Thorns grow along the stems, as well as on the leaves and leaf stalks. The leaves are palmate, usually with 5 large, oval, toothed leaflets. The leaflets are dark green on the upper surface and grayish-green below. Himalayan blackberry has white to light pink flowers, which produce a large, juicy, blackberry. The berries, which ripen between midsummer and autumn, are used as food by birds, humans and other mammals. Canes start producing berries in their second year. Individual canes may live only 2 to 3 years, with new stalks sprouting from the root crown. Himalayan blackberry can be evergreen, depending on the site.

MANAGEMENT OPTIONS: Himalayan blackberry can be controlled through mechanical and chemical means. Seedlings can be hand pulled, especially in loose soil. Plants can also be hand dug. Care should be taken to remove as much of the root as possible to prevent resprouting. Mowing can be used to control blackberries, but it must be repeated throughout the growing season. Cutting and removing canes is a very short-term solution, as more canes will sprout from the root crown. However, these new sprouts could subsequently be treated with herbicide. If canes can only be removed once in a season, the best time is when the plant starts to flower, since much of the root reserves have gone into flowering. Himalayan blackberry can also be controlled through chemical means, although some herbicides can promote vegetative growth from lateral roots. Contact the weed control board for site-specific chemical recommendations. If herbicides are used during berry production, care should be taken to prevent people from using berries.

EVERGREEN BLACKBERRY

THREAT: Evergreen blackberry is a semi-erect shrub, introduced from Eurasia as a cultivated plant. invasive as Himalayan evergreen blackberry native vegetation. It vegetatively and by the same manner as

Although not as blackberry, does take over spreads both seed, spreading in does Himalayan Blackberry. The seeds remain viable for a long period of time and are spread primarily by animals. It grows in a wide variety of habitats and soil types and does especially well in disturbed sites.

DESCRIPTION: Evergreen blackberry is a semi-erect shrub, growing to 10 feet in height. The stems are generally biennial, bear fruit in their second year and grow from perennial rootstock. As the name implies, the leaves are evergreen. Each leaf has five leaflets, which have very divided edges, quite different than the leaves of the other blackberries. The leaves are green on both sides, hairy on the underside, and the plant is well armed with thorns. The flowers are white to pink and the berries are black. As with Himalayan blackberry, evergreen blackberry reproduces both vegetatively and by seed. It produces numerous sucke, and the stems will root upon touching the ground. After disturbance, evergreen blackberry usually sprouts vigorously.

MANAGEMENT OPTIONS: Same as for Himalayan blackberry.

TRAILING BLACKBERRY

THREAT: As a native plant, trailing blackberry is part of the natural flora of Whatcom County. It can be a nuisance to landowners but is not as aggressive as the introduced species and is not a threat to other native plants.

DESCRIPTION: Trailing blackberry is a low-growing, trailing or climbing shrub, often found in wooded areas. It is an evergreen plant, which can grow 15 to 20 feet in length and form mounds. The stems are green when young, turn brown as they mature, and are densely covered with thorns. It is a much less robust plant than the two introduced species, with much thinner stems. The leaves are composed of three leaflets, which are generally more elongate than those of the Himalayan blackberry. They are green in color, lighter green on the underside, and alternate. The flowers are white to pink and the berries are black, although smaller in size than the two introduced blackberries. Trailing blackberry reproduces by seed, by suckers and by rooting at nodes on the trailing stems. The seeds are spread by animals. This plant tolerates a wide range of site conditions and sprouts readily after fire. Trailing blackberry quickly established on mudflows and other harsh sites after the eruption of Mt. St. Helens.

MANAGEMENT OPTIONS: As trailing blackberry is a native, there should not be too much need to control this plant in natural situations. If control is desired, management options are the same as for Himalayan blackberry.